FORM PTO-1390 (Modified) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE (REV 11-1700)		ATTORNEY'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		**PD990068**
		US APPLICATION NO (IF KNOWN, SEE 37 CFR 1 5) **10/089021**
INTERNATIONAL APPLICATION NO. **PCT/EP00/09311**	INTERNATIONAL FILING DATE **23 September 2000 (23.09.00)**	PRIORITY DATE CLAIMED **27 September 1999 (27.09.99)**

TITLE OF INVENTION
METHOD FOR PROCESSING VIDEO PICTURES FOR DISPLAY ON A DISPLAY DEVICE

APPLICANT(S) FOR DO/EO/US
Sebastien Weitbruch and Rainer Zwing

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C 371
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) The submission must include items (5), (6), (9) and (24) indicated below
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
    a. ☐ is attached hereto (required only if not communicated by the International Bureau).
    b. ☒ has been communicated by the International Bureau.
    c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
    a. ☐ is attached hereto.
    b. ☐ has been previously submitted under 35 U.S.C 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
    a. ☐ are attached hereto (required only if not communicated by the International Bureau).
    b. ☐ have been communicated by the International Bureau.
    c. ☐ have not been made, however, the time limit for making such amendments has NOT expired.
    d ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4))
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5))
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1 97 and 1 98.
14. ☒ An assignment document for recording A separate cover sheet in compliance with 37 CFR 3 28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1 821 - 1 825.
20. ☐ A second copy of the published international application under 35 U.S.C 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4)
22. ☒ Certificate of Mailing by Express Mail
23. ☒ Other items or information
    Return Postcard Receipt

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PCTUS1/REV03

...ICATION NO. (IF KNOWN, SEE 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
90/330291	PCT/EP00/09311	PD990068

24 The following fees are submitted..	CALCULATIONS PTO USE ONLY

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

☐ Neither international preliminary examination fee (37 CFR 1 482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	$1040.00	
☒ International preliminary examination fee (37 CFR 1 482) not paid to USPTO but International Search Report prepared by the EPO or JPO .	$890.00	
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO . .	$740.00	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) . .	$710.00	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)	$100.00	

ENTER APPROPRIATE BASIC FEE AMOUNT =	$890.00	

Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e))	$0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	7 - 20 =	0	x $18.00	$0.00	
Independent claims	1 - 3 =	0	x $84 00	$0.00	
Multiple Dependent Claims (check if applicable)			☐	$0.00	

TOTAL OF ABOVE CALCULATIONS =	$890.00	

☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2	$0.00	

SUBTOTAL =	$890.00	

Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)) +	$0.00	

TOTAL NATIONAL FEE =	$890.00	

Fee for recording the enclosed assignment (37 CFR 1 21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3 28, 3 31) (check if applicable). ☒	$40.00	

TOTAL FEES ENCLOSED =	$930.00	

	Amount to be: refunded	$
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a. ☐ A check in the amount of _____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. ___07-0832___ in the amount of ___$930.00___ to cover the above fees A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. ___07-0832___ A duplicate copy of this sheet is enclosed

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

Mr. Joseph S. Tripoli Patent Operations THOMSON multimedia Licensing Inc. PO Box 5312 Princeton, New Jersey 08540 US	SIGNATURE _/s/ Henig_ **SAMMY S. HENIG** NAME **30,263** REGISTRATION NUMBER **March 25, 2002** DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant   :   Sebastien Weitbruch and Rainer Zwing

Filed   :   Herewith

For   :   METHOD FOR PROCESSING VIDEO PICTURES FOR
              DISPLAY ON A DISPLAY DEVICE

PRELIMINARY AMENDMENT

Hon. Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Sir:

In the US national phase application of PCT/EP00/09311 filed herewith, please enter the following amendments:

IN THE SPECIFICATION:

Please amend the specification as follows:

On Page 1, line 4, please insert the following paragraph:

-- This application claims the benefit, under 35 U.S.C. § 365 of International Application PCT/EP00/09311, filed September 23, 2000, which was published in accordance with PCT Article 21(2) on April 5, 2001 in English and which claims the benefit of European patent application No. 99118990.3 filed September 27, 1999 --

IN THE CLAIMS:

Please amend the claims (which are annexes of the International Preliminary Examination Report) as follows. A marked-up version of the claims is attached herewith.

1. (AMENDED) Method for processing video pictures for display on a display device having a plurality of luminous elements corresponding to the pixels of a picture, wherein the time duration of a video frame or video field is divided into a plurality of sub-fields during which the luminous elements can be

activated for light emission in small pulses corresponding to a sub-field code word which is used for brightness control, wherein with motion estimation motion vectors are calculated in pixel resolution for the pixels in a video picture, further comprising a step of performing correction of the video values or sub-field code words for the pixels along the direction of motion determined by the motion vector, wherein, the motion vector field is restricted to discrete motion vectors having the characteristic that the discrete motion vectors have a more symmetrical arrangement with regard to the pixels on which they lie than the excluded motion vectors, wherein if a calculated motion vector is not part of the restricted motion vector field, it is exchanged by a neighboring motion vector of the restricted motion vector field, wherein the exchanged motion vector serves for calculating an optimised correction trajectory that determines at which pixel positions along the motion vector the correction values are placed for dynamic false contour compensation.

2.   (AMENDED) Method according to claim 1, wherein the following steps are used for determining the neighboring motion vector in the restricted motion vector field for a calculated motion vector:

first, the smallest motion vector component S of the calculated motion vector is selected where $S=\min(V_x,V_y)$ with V_x and V_y being the motion vector components of the calculated motion vector;

second, the ratio R between S and the other motion vector component V_i is calculated, where $R=V_i/S$ and $V_i=\max(V_x,V_y)$, with $i \in [x,y]$;

third, the ratio R is rounded and the other motion vector component V_i is updated according to the formula $V'_i = round(R) \cdot S$, where the determined neighboring motion vector has the components S and V'_i.

3.   (AMENDED) Method according to claim 1, wherein for calculating the motion vectors in pixel resolution the motion vector components are rounded to integer values before the conversion, wherein in the rounding step the vector components are rounded down irrespective of their rational component value.

4.   (AMENDED) Method according to claim 1, wherein for calculating the
      correction values sub-field code word entry shifts are calculated for a pixel in
      dependence of the corresponding motion vector from the restricted motion
      vector field and wherein a rounding step is performed for each shift component
      during sub-field code word entry shift calculation, wherein in the rounding step
      the shift components are rounded down irrespective of their rational component
      value.

5.   (AMENDED) Method according to claim 1, wherein a correction for dynamic
      false contour effect compensation is made by calculating correction values on
      signal amplitude level and distributing the correction values among a number of
      pixels which are located along a motion vector from the restricted motion
      vector field determined for a pixel of the picture.

7.   (AMENDED) Method according to claim 1, wherein it is used in a plasma
      display apparatus.

IN THE ABSTRACT:

<div align="center">Please add the following Abstract.</div>

        -- With the new plasma display panel technology new kinds of
artefacts can occur in video pictures. These artefacts are commonly described as
"dynamic false contour effect", since they correspond to disturbances of gray levels
and colors in the form of an apparition of colored edges in the picture when the
observation point on the PDP screen moves. Often, such an artefact is compensated
by analyzing the motion in the pictures, assigning to a pixel a corresponding motion
vector and performing a re-coding step in which the different sub-fields code word
entries of a pixel are shifted to distribute the sub-fields of a pixel more closely on the
eye trajectory. It is disclosed a procedure for transforming the motion vectors into a
more symmetrical form before applying the compensation in order to better respect
the symmetry of the human visual system. It has proved to be advantageous to better
make an under-compensation by rounding down the motion vector components
irrespective of their rational component value before symmetrization. A further aspect

of the invention is a specific rounding process used for calculating the correction pixel locations when making a correction on signal amplitude level instead of sub-field level. --

<div align="center">

REMARKS

</div>

The specification has been amended to include a reference to the priority applications.

Claims 1-5 and 7 (which are annexes of the International Preliminary Examination Report) have been amended to remove reference indicia, to remove multiple dependences and to meet the requirements of the United States Patent and Trademark Office. Claim 6 is unchanged.

To meet the requirements of the United States, the Abstract (as originally filed in the PCT application) is added.

No fee is believed to have been incurred by virtue of this amendment. However if a fee is incurred on the basis of this amendment, please charge such fee against deposit account 07-0832

Respectfully submitted,
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March 25, 2002

MARKED UP VERSION OF THE AMENDED CLAIMS

Please amend the claims (which are annexes of the International Preliminary Examination Report) as follows. A marked-up version of the claims is attached herewith.

1. (AMENDED) Method for processing video pictures for display on a display device having a plurality of luminous elements corresponding to the pixels of a picture, wherein the time duration of a video frame or video field is divided into a plurality of sub-fields [(SF)] during which the luminous elements can be activated for light emission in small pulses corresponding to a sub-field code word which is used for brightness control, wherein with motion estimation motion vectors [(MV)] are calculated in pixel resolution for the pixels in a video picture, further comprising a step of performing correction of the video values or sub-field code words for the pixels along the direction of motion determined by the motion vector, [characterized in that] wherein, the motion vector field is restricted to discrete motion vectors having the characteristic that the discrete motion vectors have a more symmetrical arrangement with regard to the pixels on which they lie than the excluded motion vectors, wherein if a calculated motion vector is not part of the restricted motion vector field, it is exchanged by a neighboring motion vector of the restricted motion vector field, wherein the exchanged motion vector [(MV)] serves for calculating an optimised correction trajectory that determines at which pixel positions along the motion vector [(MV)] the correction values are placed for dynamic false contour compensation.

2. (AMENDED) Method according to claim 1, wherein the following steps are used for determining the neighboring motion vector in the restricted motion vector field for a calculated motion vector:

first, the smallest motion vector component S of the calculated motion vector [(MV)] is selected where $S=\min(V_x,V_y)$ with V_x and V_y being the motion vector components of the calculated motion vector;

second, the ratio R between S and the other motion vector component V_i is calculated, where $R=V_i/S$ and $V_i=\max(V_x,V_y)$, with $i \in [x,y]$;

third, the ratio R is rounded and the other motion vector component V_i

is updated according to the formula $V'_i = round(R) \cdot S$, where the determined neighboring motion vector has the components S and V'_i.

3. (AMENDED) Method according to claim 1 [or 2], wherein for calculating the motion vectors in pixel resolution the motion vector components are rounded to integer values before the conversion, wherein in the rounding step the vector components are rounded down irrespective of their rational component value.

4. (AMENDED) Method according to [one of claims 1 to 3] claim 1, wherein for calculating the correction values sub-field code word entry shifts are calculated for a pixel in dependence of the corresponding motion vector from the restricted motion vector field and wherein a rounding step is performed for each shift component during sub-field code word entry shift calculation, wherein in the rounding step the shift components are rounded down irrespective of their rational component value.

5. (AMENDED) Method according to [one of claims 1 to 3] claim 1, wherein a correction for dynamic false contour effect compensation is made by calculating correction values on signal amplitude level and distributing the correction values among a number of pixels which are located along a motion vector from the restricted motion vector field determined for a pixel of the picture.

7. (AMENDED) Method according to [one of claims 1 to 6] claim 1, wherein it is used in a plasma display apparatus.

Method for processing video pictures for display on a dis-
play device

5   The invention relates to a method for processing video pic-
    tures for display on a display device.
    More specifically the invention is closely related to a kind
    of video processing for improving the picture quality of
    pictures which are displayed on matrix displays like plasma
10 display panels (PDP) or other display devices where the
    pixel values control the generation of a corresponding num-
    ber of small lighting pulses for luminance degration on the
    display.

15 Background
    The Plasma technology now makes it possible to achieve flat
    color panel of large size (greater than possible with CRTs)
    with very limited depth and without any viewing angle con-
    straints.

20
    Referring to the last generation of european TV sets, a lot
    of work has been made to improve its picture quality. Conse-
    quently, a new technology like the Plasma one has to provide
    a picture quality as good or better than standard TV tech-
25 nology. On one hand, the Plasma technology gives the possi-
    bility of "unlimited" screen size, of attractive thickness
    but on the other hand, it generates new kinds of artefacts
    which could degrade the picture quality.

30 Most of these artefacts have a different appearing than
    those in the TV pictures on CRT screen and that makes them
    more visible since people are used to seeing the old TV ar-
    tefacts unconsciously.

35 The subject artefact, with which the invention deals, is
    called "dynamic false contour effect" since it corresponds

to disturbances of gray levels and colors in the form of an
apparition of colored edges in the picture when an observa-
tion point on the PDP screen moves. The effect is most visi-
ble when the image has a smooth gradation like skin.

5

Fig. 1 shows the simulation of such a false contour effect
on a natural scene with skin areas. On the arm of the dis-
played woman are shown two dark lines, which e. g. are
caused by this false contour effect. Also in the face of the

10 woman such dark lines occur on the right side.

In addition, the same problem occurs on static images when
observers are moving their heads and that leads to the con-
clusion that such a failure depends on the human visual per-

15 ception and happens on the retina.

Some algorithms are known today, which are based on motion
estimation in video pictures in order to be able to antici-
pate the motion of the critical observation points to reduce

20 or suppress this false contour effect. In most cases, these
different algorithms are focused on the sub-field coding
part without giving detailed information concerning the mo-
tion estimators used.

25 In the past, the motion estimator evolution was mainly fo-
cused on flicker-reduction for european TV standards (e.g.
upconversion from 50Hz to 100Hz) or proscan conversion and
for video compression in the scope of MPEG-encoding and so
one. Nevertheless, the problems which have to be solved for

30 such applications are different from the PDP dynamic false
contour issue.

A Plasma Display Panel (PDP) utilizes a matrix array of dis-
charge cells which could only be "ON" or "OFF". Also unlike

35 a CRT or LCD in which gray levels are expressed by analog
control of the light emission, a PDP controls the gray level

by modulating the number of light pulses per frame. This time-modulation will be integrated by the eye over a period corresponding to the eye time response.

5   When an observation point (eye focus area) on the PDP screen moves, the eye will follow this movement. Consequently, it will no more integrate the light from the same cell over a frame period (static integration) but it will integrate information coming from different cells located on the move-

10   ment trajectory and it will mix all these light pulses together which leads to a faulty signal information.

Today, a basic idea to reduce this false contour effect is to detect the movements in the picture (displacement of the

15   eye focus area) and to apply different type of corrections over this displacement in order to be sure the eye will only perceive the correct information through its movement. These solutions are described e.g. in EP-A-0 980 059 and EP-A-0 978 816 which are published European Patent Applica-

20   tions of the applicant.

As already mentioned, a dynamic false contour effect reduction can be done by making specific corrections on a movement trajectory defined by the motion vectors.

25

Since a PDP is a matrix array of plasma cells, each kind of correction has to respect this matrix segmentation of the panel. A motion vector, will therefore be used to determine in the matrix of pixels a trajectory to apply the compensa-

30   tion. For that purpose it is necessary to convert a vector in a discrete trajectory which can lead to faulty or partial compensations.

Invention

According to the invention it is proposed a way to improve
the quality of the false contour effect reduction using a
standard motion estimator with a post-processing of the es-
5   timated motion-vectors according to the human visual system.

It can be implemented for each kind of Plasma technology at
each level of its development (even if the scanning mode and
sub-field distribution is not well defined).

10

In the method according to this invention, the characteris-
tics of the human visual system are used to implement a post
processing on the vectors coming from the motion estimator.
That makes possible to define a compensation trajectory re-
15   specting the human eye in order to improve the global qual-
ity of the compensation.

One aspect of the invention is that the estimated motion
vectors are converted into a more symmetrical form which al-
20   lows to distribute corrections along the vector more symmet-
rically around the vectors. This respects better the behav-
ior of the human visual system. An advantageous algorithm
for this conversion is claimed in claim 2.

25   This algorithm is relatively simple to implement since it
does not request complicated computations.

To further improve the compensation method it is advanta-
geous that the motion vector components estimated for a
30   pixel are rounded down to integer values irrespective of the
rational component value of each vector component before
symmetrization. This has the advantage that over-
compensation is reliably avoided. In contrast, this means
that under-compensation is taken instead. Over-compensation
35   has the disadvantage that the false contour changes its ap-

pearance. E.g. a different color can occur due to over-
compensation. This is very disturbing for the viewer.

A third aspect of the invention concerns a specific rounding
5 process for calculating the positions of corrections on sig-
nal level as claimed in claim 6. According to this rounding
process, the pixel coordinates for a correction value are
rounded down if the rational component of the pixel coordi-
nate is in a lower range, the pixel coordinate is rounded up
10 and rounded down if the rational component is in a medium
range thus determining two correction positions, the pixel
coordinates for a correction value are rounded up if the ra-
tional component of the pixel coordinate is in an upper
range.
15

Drawings

Exemplary embodiments of the invention are illustrated in
the drawings and are explained in more detail in the follow-
20 ing description.

In the figures:

Fig. 1   shows a video picture in which the false contour
25   effect is simulated;

Fig. 2   shows an illustration for explaining the sub-field
           organization of a PDP;

Fig. 3   shows an illustration for explaining the false
30   contour effect;

Fig. 4   illustrates the appearance of a dark edge when a
           display of two frames is being made in the manner
           shown in Fig. 3;

35

Fig. 5   shows a possible trajectory for distributing false
            contour corrections along a motion vector of a
            critical observation point on a plasma screen;

5   Fig. 6   shows a model how the human brain analysis visual
            information;

Fig. 7   shows a 3D-illustration of a gabor wavelet used in
            the model of Fig.6;

10

Fig. 8   shows a 2D-illustration of a gabor wavelet pro-
            jected on a plasma screen;

Fig. 9   shows a first illustration of distributing correc-
15   tions along a motion vector which will lead to a
            non-optimal false contour correction;

Fig. 10   shows a sub-field organisation with 12 sub-fields;

20 Fig. 11   shows the centers of gravity for the sub-fields of
            the sub-field organisation shown in Fig.10;

Fig. 12   shows a second illustration of distributing cor-
            rections along a motion vector respecting the sym-
25   metry of the gabor function;

Fig. 13   shows a third illustration of distributing correc-
            tions along a motion vector not respecting the
            symmetry of the gabor function;

30

Fig. 14   shows an illustration of a special rounding proc-
            ess for distributing corrections on signal ampli-
            tude level instead of sub-field level;

Fig. 15   shows an illustration of distributing corrections
           on signal amplitude level along a motion vector
           applying a first specific rounding scheme; and

5   Fig. 16   shows an illustration of distributing corrections
               on signal amplitude level along a motion vector
               applying a second specific rounding scheme.

10   Exemplary embodiments
     As previously mentioned, a Plasma Display Panel (PDP) util-
     izes a matrix array of discharge cell which can only be "ON"
     or "OFF". The PDP controls the gray level by modulating the
     number of light pulses per frame. This time modulation will
15   be integrated by the eye over a period corresponding to the
     human eye time-response.

     In TV technology an 8 bit representation of the luminance
     levels for the RGB colour components is very common. In that
20   case each level will be represented by a combination of the
     8 following bits :
                    1 - 2- 4 - 8 - 16 - 32 - 64 - 128

     To realize such a coding with the PDP technology, the frame
25   period will be divided in 8 lighting periods (called sub-
     fields), each one corresponding to a bit. The number of
     light pulses for the bit "2" is the double as for the bit
     "1" and so on. With these 8 sub-periods, it is possible
     through combination, to build the 256 different luminance
30   levels. Without motion, the eye of the observers will inte-
     grate over about a frame period these sub-periods and catch
     the impression of the right gray level. Fig. 2 represents
     this decomposition. In this figure the addressing and eras-
     ing periods of every sub-field are not shown. The plasma
35   driving principle however requires also these periods. It is
     well known to the skilled man, that during each sub-field a

plasma cell needs to be addressed, first in an addressing or
scanning period, afterwards the sustain period follows where
the light pulses are generated and finally in an erase pe-
riod the charge in the plasma cells is quenched.

5

This PWM-type light generation introduces new categories of
image-quality degradation corresponding to disturbances of
gray levels or colors. The name for this effect is dynamic
false contour effect since the fact that it corresponds to
10   the apparition of colored edges in the picture when an ob-
servation point on the PDP screen moves. Such failures on a
picture leads to an impression of strong contours appearing
on homogeneous area like skin. The degradation is enhanced
when the image has a smooth gradation and also when the
15   light-emission period exceeds several milliseconds. In addi-
tion, the same problems occur on static images when observ-
ers are moving their heads and that leads to the conclusion
that such a failure depends on the human visual perception.

20   To understand a basic mechanism of visual perception of mov-
ing plasma images, a simple case will be considered. Let us
assume a transition between the level 128 and 127 moving at
5 pixel per frame, and the eye following this movement.

25   Fig. 3 represents in light gray the lighting sub-fields cor-
responding to the level 127 and in dark gray, these corre-
sponding to the level 128.

The diagonal parallel lines originating from the eye indi-
30   cate the behavior of the eye integration during a movement.
The two outer diagonal eye-integration-lines show the
borders of the region with faulty perceived luminance. Be-
tween them, the eye will perceive a lack of luminance which
leads to the appearing of a dark edge as indicated in the
35   eye stimuli integration curve at the bottom of Fig. 3.

This is also illustrated in Fig. 4 for the same moving transition.

The false contour effect is produced on the eye retina when the eye follows a moving object since the eye does not integrate the right information at the right time. There are different methods to reduce such an effect but the more serious ones are based on motion estimation (dynamic methods) which aim to detect the movement of each pixel in a frame in order to anticipate the eye movement and to reduce the failure appearing on the retina through different corrections. In other words, the goal of each dynamic algorithm is to define for each pixel observed by the eye, the way the eye is following its movement during a frame in order to generate a correction on this trajectory. Such algorithms are described e.g. in EP-A-0 980 059 and EP-A-0 978 816 which are European patent applications of the applicant.

Consequently, for each pixel of the frame N, there is a motion vector $\vec{V} = (V_x; V_y)$ which describes the complete motion of the pixel from the frame N to the frame N+1. Nevertheless, the goal of a false contour compensation is to apply a compensation on the complete trajectory. In other words, such an algorithm needs a way to convert this vector in a trajectory on a matrix display.

Taking the example of a vector $\vec{V} = (7;3)$, as shown in Fig. 5, it is evident that the definition of this vector is not enough to determine one trajectory. On trajectory is shown in the figure with dashed line. There are other possibilities to distribute corrections along the vector.

In Fig. 5, the vector represents the real motion of a pixel, that means the real trajectory the eye will follow when it locks this pixel. The dashed line represents a possible trajectory in the matrix array. Yet, there are different

jectory in the matrix array. Yet, there are different trajectories possible and it is necessary to define a trajectory as near as possible from the eye integration trajectory. According to the invention this is done according to

5 the human visual system which will be described more in detail hereinafter.

The complete human visual system can be seen as a picture encoder to reduce the information received by the retina to

10 the essential information which could be rapidly interpreted by the brain.

For instance, the pupil can be seen as a low-pass filter which reduces the amount of high spacial frequencies. It is

15 not required here, to make a complete exposition of the human visual system but to extract some important characteristics from the HVS to explain the ideas included in this invention disclosure.

20 One key point of the human visual system is the fact that the cortex areas will analyse the incoming picture with a discrete filter bank as illustrated in Fig. 6.

This figure shows that the signal coming from the eye will

25 be analyzed in preferential directions and the number of these directions is limited (discrete analysis). The signal for each direction is analysed in a filter bank for different spacial frequencies.

30 In fact, medical experiments have shown that this decomposition by means of a filter bank can be seen as a mathematical decomposition in gabor wavelets and describe very good the behaviour of the simple receptor fields of the cortex cells.

35 The mathematic formula of such a gabor wavelet is the following one:

11

$$f_o = \exp\left(-\pi\left[(x - x_o)^2 a^2 + (y - y_o)^2 b^2\right]\right) \times \exp\left(-2i\pi\left[u_o(x - x_o) + v_o(y - y_o)\right]\right) \quad \text{where}$$

(x_o, y_o) represents the position of the directional filter modulated by the spacial frequencies (u_o, v_o) and with an orientation of $\arctan\left(\dfrac{v_o}{u_o}\right)$, a and b are parameters. The value f_0

5 represents the excitation intensity in the brain corresponding to the perception strength.

In Fig. 7 the characteristic of such a gabor function is illustrated. In the left part of Fig. 7 a 3D plot of the gabor
10 function is given, in the right part of Fig. 7 the characteristic of the gabor function is illustrated with a colored 2D plot of the same function.

These graphics show how the eye will analyse an object tran-
15 sition or a movement in a spacial direction.
In Fig. 8 the 2D plot of the gabor function for a moving pixel with motion vector $\vec{V} = (7,3)$ is shown, the same pixel movement is shown in Fig. 6.

20 In Fig. 8, the middle area (directly arround the vector) represents the more sensitive one for the eye integration. Consequently, each kind of dynamic false contour compensation should be spread over this area which is important for the definition of the compensation trajectory.

25

It is a basic aspect of the invention to define a vector post-processing method which enables such an adapted compensation.

30 In theory, the different motion vectors could have any kind of values and so any kind of direction. For a computer algorithm in plasma displays it is however advantageous to convert the two vector components to integer values.

The aim of each compensation is to reduce, in the right direction taking into account the right amplitude of the movement, the false contour effect.

5

In fact, since the compensation has to be applied on a matrix array of pixels (discrete positions), the two motion vector components have to be integer ones to apply a correction on a discrete trajectory (defined with integers). In that case, it is necessary to round the vector components coming from the motion estimator. Every kind of rounding can be taken. Nevertheless, experiments made on different available motion estimators showed that a rounding down can improve the final result. In order to simplify the further explanations in the following it is presupposed that all motion vectors are rounded down.

It is obvious that a compensation which is based on a lower value of the movement amplitude but which respects the right direction will still provide a gain in the reduction of the false contour. On the other hand, if the compensated motion amplitude is too high, this will generate a false contour effect in the opposite level to the effect we will try to compensate. In addition, the fact to jump from an under-compensation to an over-compensation will suddenly change the color of the false contour and that makes it more visible, too.

Consequently, according to the invention for all computations one kind of rounding is precisely defined and in addition under-compensation is used, i.e. the used motion amplitude is lower than the real one.

According to this, the first stage of the new compensation algorithm will convert each vector component to an integer value with a rounding down to the neariest lower integer:

$$\vec{V}_1 = \vec{V}\left(round \downarrow (V_x), round \downarrow (V_y)\right).$$

Before going further, an example of an improperly compensation is illustrated in Fig. 9. In this figure a compensation based on 10 corrections from 0 to 9 is illustrated for the motion vector $\vec{V} = (7;3)$.

The number 0 to 9 corresponds in each case to one of the ten elements of the compensation. It is evident from Fig. 9 with the 2D-plot of the gabor function included, that this compensation does not respect the symmetry of the human eye integration function and thus leads to a non-optimal false contour correction.

As explained above, the human cerebral cortex decomposes each movement and stimuli in preferential directions. In fact, since the human visual system does not dispose of an infinite number of such directions, those directions can be defined as discrete ones. For that purpose one principle of the new algorithm is to convert the motion vectors to a discrete number of directions (convert all vectors to specific ones which leads to a more symmetrical compensation).

The vector components are rounded to integers and consequently, the direction given by each vector is based on the ratio between the two integer vector components. In order to create a discrete space of directions, a good possibility is to define which integer ratios are allowed for motion vectors. For that purpose, the second stage of the processing will correspond to a modification of the vector components as described below:

select the smallest vector component: $S = \min(V_x, V_y)$

compute the ratio R between S and the larger vector compo-
nent: $R = \dfrac{V_i}{S}$ in which $V_i = \max(V_x, V_y)$

round the ratio R and then update the larger vector compo-
nent: $V_i' = round(R) \times S$.

5

For instance the vector $\vec{V}(7;3)$ will be converted to the vec-
tor $\vec{V}'(6;3)$ and the vector $\vec{V}(2;9)$ will be converted to $\vec{V}'(2;8)$.
These two vectors are elements of a discrete space of vec-
tors and their form leads to a better symmetry of the com-

10   pensation.

Now, this processing will be illustrated through an example
based on a Sub-field shifting algorithm. This algorithm is
explained in detail EP-A-0 980 059, which is a European Pat-

15   ent Application of the applicant. For the disclosure regard-
ing this algorithm it is therefore expressively referred to
this patent application.

The complete algorithm can best be explained with a concrete

20   example. For this example, the sub-field organisation shown
in Fig. 10 is selected. Considered is a motion vector de-
fined by

$$\vec{V} = (7.3; 3.7) .$$

Rounding down of the vector components results in the motion

25   vector

$$\vec{V}' = (7;3) .$$

Conversion of the new vector to a basic one results in

$$\vec{V}'' = (6;3) .$$

30   The main idea of the sub-field shifting algorithm is to an-
ticipate the movement in order to position the different bit
planes of the moving area on the eye integration trajectory.
That means the different bit-planes are shifted depending on

the eye movement to make sure that the eye receives the
right information at the right time. For that purpose
centers of gravity have been defined for the sub-fields:

$$G(n) = \sum_{i=1}^{i=n-1} Dur(i) + \frac{Dur(n)}{2}$$

5   in which G() represents the center of gravity location in
the frame, n the current sub-field and Dur() the duration of
the sub-field. This duration includes the addressing time as
but not the erasing time:

$$Dur(n) = Tadd + Tn$$

10   in which Tadd represents the duration of the addressing pe-
riod and Tn the duration of the sustain period of the sub-
field itself. The erasing period is subjectively smaller and
is in this embodiment neglected but can alternatively also
be taken into account in another embodiment.

15

The resulting centers of gravity for the considered sub-
field organisation are shown in Fig. 11.

Giving a motion vector $\vec{V} = (Vx;Vy)$, for a current pixel, the
20   entries in the sub-field code word for this pixel will be
shifted to new pixel positions, where the shift coordinates
are calculated according to the following formulae:

$$\Delta x_n = \frac{Vx \cdot G(n)}{Dur(F)} \quad \text{and} \quad \Delta y_n = \frac{Vy \cdot G(n)}{Dur(F)}$$

in which, Dur(F) represents the complete duration of the
25   frame.

In the above mentioned example where $\vec{V} = (6;3)$, the following
results are achieved:

Sub-field N° i	1	2	3	4	5	6	7	8	9	10	11	12
Δ_x^i	0.01	0.05	0.1	0.26	0.54	1.1	1.85	2.6	3.36	4.1	4.87	5.6
Δ_y^i	0.005	0.02	0.06	0.13	0.27	0.55	0.93	1.3	1.68	2.05	2.43	2.8

Since a correction can only be applied at distinct pixel
positions defined by two coordinates in the matrix of pixel,
it is required to round the previous computed values. Dif-
ferent kind of rounding regulations could be applied and for
5   this example a round down process of each previous computed
coordinate has been chosen to make under-compensation. How-
ever, it is mentioned that also some other kind of rounding
could be used here. With rounding down, the following re-
sults are achieved.

Sub-field N° i	1	2	3	4	5	6	7	8	9	10	11	12
$\Delta_x{}'$	0	0	0	0	0	1	1	2	3	4	4	5
$\Delta_y{}'$	0	0	0	0	0	0	0	1	1	2	2	2

10
In Fig. 12 the resulting compensation is illustrated. For
the first 5 sub-fields, there is no shifting at all. The
sub-field entries for the sixth and seventh sub-field are
shifted one pixel to the right. The sub-field entry for the
15   12th sub-field is shifted five pixels to the right and three
pixels upwards. All the remaining shifts can easily be seen
from Fig. 12.

This compensation shall be compared to a standard compensa-
20   tion based on the rounded motion vector $\vec{V}'=(7;3)$ but without
rounding of the vector component ratio and adjusting of the
larger vector component in the following table and in Fig.
13. In both figures Fig. 12 and Fig. 13 the motion vector
$\vec{V}'=(7;3)$ is depicted and the compensation results for this
25   vector can be directly compared. Of course, in Fig. 12 the
correction results are based on a calculation with the con-
verted vector $\vec{V}''=(6;3)$. It is evident from this comparison
that the compensation based on $\vec{V}''=(6;3)$ respects more the
symmetry of the human visual system for the motion vector
30   $\vec{V}'=(7;3)$ as those based directly on vector $\vec{V}'=(7;3)$.

Sub-field N° i	1	2	3	4	5	6	7	8	9	10	11	12
Δ_x^i	0.01	0.05	0.14	0.3	0.63	1.29	2.17	3.05	3.92	4.8	5.68	6.56
Δ_y^i	0.006	0.02	0.06	0.13	0.27	0.55	0.93	1.3	1.68	2.05	2.43	2.8

A comparison of Fig. 12 with Fig. 13 shows that the compensation result shown in Fig. 13 second one does not respect the symmetry of the human visual system. There are five cor-

5   rections on pixel positions below the motion vector against only one correction on pixel positions above the motion vector. In that case, simulations showed some artefact produced by the compensation itself even in areas where no false contour is visible. In addition, when the vector space is dis-

10   crete, the compensation stays more stable between two serious vector changes.

Today, there are a number of false contour correction methods based on motion vectors which make a correction on the

15   signal amplitude basis for a pixel, not on sub-field level. In that case, one possibility is to add a positive or negative signal amplitude to the original pictures at different positions depending on the motion vectors. There are also some other possibilities known which can be used here but

20   will not be further mentioned in this application.

In the considered case, at each matrix position a combination of two or more corrections can be applied. Consequently, giving a correction, one or two positions for this

25   correction can be defined in the matrix.

Let N be the number of corrections for a the critical moving pixels of a picture. Then a simple way to determine a correction trajectory for the motion vector $\vec{V} = (V_x; V_y)$ is to com-

30   pute the position $P_i = (\Delta_x^i; \Delta_y^i)$ for each correction item, with i

= 1,…,N is defined by the formula : $\Delta_x^i = i \times \dfrac{V_x}{N}$ and $\Delta_y^i = i \times \dfrac{V_y}{N}$.

This is simple but does not respect the symmetry of the ga-
bor function. Nevertheless, in order to respect the symmetry
of the gabor function, a special rounding processing will be
applied according to another aspect of the invention. This
aims to produce an artificial symmetry in the compensation.
In that case, each compensation could be applied at one or
two positions like described below and illustrated in Fig.
14. Fig. 14 illustrates the following processing:

If $\Delta'_\varepsilon = i \times \dfrac{V_\varepsilon}{N} \leq I\% \times round \uparrow \left(i \times \dfrac{V_\varepsilon}{N} \right)$ then $\Delta'_\varepsilon = round \downarrow \left(i \times \dfrac{V_\varepsilon}{N} \right)$ with ε ele-

ment of $\{x,y\}$ and i = 1, ..., N

If $I\% \times round \uparrow \left(i \times \dfrac{V_\varepsilon}{N} \right) < \Delta'_\varepsilon = i \times \dfrac{V_\varepsilon}{N} \leq S\% \times round \uparrow \left(i \times \dfrac{V_\varepsilon}{N} \right)$ then

$$\Delta'_\varepsilon = \begin{vmatrix} round \downarrow \left(i \times \dfrac{V_\varepsilon}{N} \right) \\ round \uparrow \left(i \times \dfrac{V_\varepsilon}{N} \right) \end{vmatrix}.$$

If $\Delta'_\varepsilon = i \times \dfrac{V_\varepsilon}{N} > S\% \times round \uparrow \left(i \times \dfrac{V_\varepsilon}{N} \right)$ then $\Delta'_\varepsilon = round \uparrow \left(i \times \dfrac{V_\varepsilon}{N} \right)$.

Here, round↑ means rounding up of the value in brackets and
round↓ means the mathematical operation of rounding down the
value in brackets. I% is the programmable border for the
rounding down region and S% is the corresponding border for
the rounding up region. Obviously, the border I% and S%
could have different values depending on the compensation
algorithm used. The region inbetween the borders I% and S%
is a region where rounding down and rounding up of the cor-
rection position components is being done thus leading to
two correction positions in case there is only one component
treated in this way and leading to four correction positions
in case there are components treated in this way.

Also this processing is illustrated with a simple example in
which the vector $\vec{V}=(6;3)$ and N=9 is used. First, the case is
considered with the borders I%=40% and S%=60%:

5 The following table shows the computation of the positions
for the 9 correction positions defined by $P_i=\left(\Delta'_x;\Delta'_y\right)$

Correction N° i	1	2	3	4	5	6	7	8	9
Δ_x^i	1	1	2	3	3	4	5	5	6
Δ_y^i	0	1	1	1	2	2	2	3	3

In that case, the implementation of the correction will look
like as depicted in Fig. 15.

10

The numbers used in Fig. 15 denote the correction positions
in the pixel matrix. The correction values for these posi-
tions need to be calculated. In the easiest case a constant
value can be used which adds or subtracts some luminance to
15 the pixels of each correction position depending on the mov-
ing transition. Higher sophisticated correction value dis-
tribution algorithms can also be used e.g. a correction
based on an algorithm which makes the correction values in-
crease and decrease with the correction number. Examples of
20 these algorithms are described in the articles:

◊ "4.3: An equalizing Pulse Technique for improving
the Gray Scale Capability of Plasma Displays" – Euro
Displays '96
◊ "15.3: A motion dependent equalizing-pulse technique
25 for reducing gray-scale disturbances on PDPs" – SID
97 DIGEST (copy).
Therefore, these algorithms need not be described in greater
detail here.

30 The next case considered is the case with I%=30%, S%=70% and
the same motion vector and number of corrections.

The following table shows the new computation results of the positions for the 9 corrections defined by $P_i = \left(\Delta'_x; \Delta'_y\right)$.

Correction N° i	1	2	3	4	5	6	7	8	9
$\Delta_x^{'}$	0, 1	1	2	2, 3	3	4	4, 5	5	6
$\Delta_y^{'}$	0	0, 1	1	1	1, 2	2	2	2, 3	3

Fig. 16 shows how the compensation will look like. Here, there are a lot of correction position components rounded up and down, thus duplicating the number of corrections. Consequently, a change of the values from I% and S% will have an impact of the density of the corrections on the movement trajectory.

In fact, in the cells containing more than one correction, a combination of these corrections will be necessary and will depend of the correction type. One possibility to make a combination is to take the mean value of all the correction values for this position.

Claims

1. Method for processing video pictures for display on a
   display device having a plurality of luminous elements
5 corresponding to the pixels of a picture, wherein the
   time duration of a video frame or video field is
   divided into a plurality of sub-fields (SF) during
   which the luminous elements can be activated for light
   emission in small pulses corresponding to a sub-field
10 code word which is used for brightness control, wherein
   with motion estimation motion vectors (MV) are
   calculated in pixel resolution for the pixels in a
   video picture, further comprising a step of performing
   correction of the video values or sub-field code words
15 for the pixels along the direction of motion determined
   by the motion vector, **characterized in that**, the motion
   vector field is restricted to discrete motion vectors
   having the characteristic that the discrete motion
   vectors have a more symmetrical arrangement with regard
20 to the pixels on which they lie than the excluded
   motion vectors, wherein if a calculated motion vector
   is not part of the restricted motion vector field, it
   is exchanged by a neighbouring motion vector of the
   restricted motion vector field, wherein the exchanged
25 motion vector (MV) serves for calculating an optimised
   correction trajectory that determines at which pixel
   positions along the motion vector (MV) the correction
   values are placed for dynamic false contour
   compensation.

30

2. Method according to claim 1, wherein the following steps
   are used for determining the neighbouring motion vector
   in the restricted motion vector field for a calculated
   motion vector:

35   first, the smallest motion vector component S of

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the calculated motion vector (MV) is selected where
S=min(V_x,V_y) with V_x and V_y being the motion vector
components of the calculated motion vector;

5   second, the ratio R between S and the other motion
vector component V_i is calculated, where R=V_i/S and
V_i=max(V_x,V_y), with $i \in [x,y]$;

third, the ratio R is rounded and the other motion
vector component V_i is updated according to the formula
$V'_i = round(R) \cdot S$, where the determined neighbouring motion
10   vector has the components S and V'_i.

3.   Method according to claim 1 or 2, wherein for
calculating the motion vectors in pixel resolution the
motion vector components are rounded to integer values
15   before the conversion, wherein in the rounding step the
vector components are rounded down irrespective of their
rational component value.

4.   Method according to one of claims 1 to 3, wherein for
20   calculating the correction values sub-field code word
entry shifts are calculated for a pixel in dependence of
the corresponding motion vector from the restricted
motion vector field and wherein a rounding step is
performed for each shift component during sub-field code
25   word entry shift calculation, wherein in the rounding
step the shift components are rounded down irrespective
of their rational component value.

5.   Method according to one of claims 1 to 3, wherein a
30   correction for dynamic false contour effect compensation
is made by calculating correction values on signal
amplitude level and distributing the correction values
among a number of pixels which are located along a

motion vector from the restricted motion vector field
determined for a pixel of the picture.

6. Method according to claim 5, wherein the pixel positions

$P_i = \left(\Delta'_x ; \Delta'_y \right)$ which are used for correction value

distribution are calculated with the formulae $\Delta'_x = i \times \dfrac{V_x}{N}$

and $\Delta'_y = i \times \dfrac{V_y}{N}$, where N is the number of pixels over which

the correction value is to be distributed corresponding

to the length of the motion vector $\vec{V} = \left(V_x ; V_y \right)$, where i is

an index running from 1 to N, wherein a specific
rounding process is used for correction pixel location,
wherein if the rational component value of a pixel
coordinate Δ'_x, Δ'_y is in a first range, the pixel
coordinate is rounded down, wherein if the rational
component value of a pixel coordinate is in a second
range above the first range, the pixel coordinate is
rounded up and down thus leading to two different
correction positions in parallel, and wherein if the
rational component value of a pixel coordinate Δ'_x, Δ'_y
is in a third range above the second range, the pixel
component is rounded up.

7. Method according to one of claims 1 to 6, wherein it is
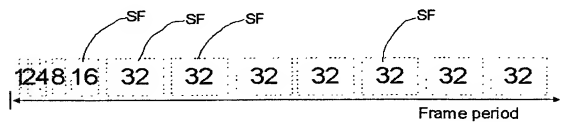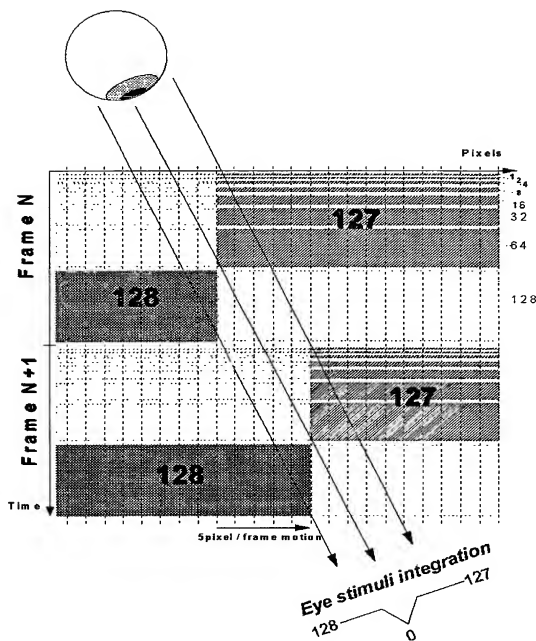used in a plasma display apparatus.
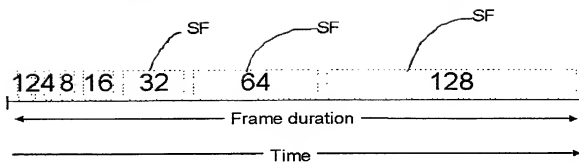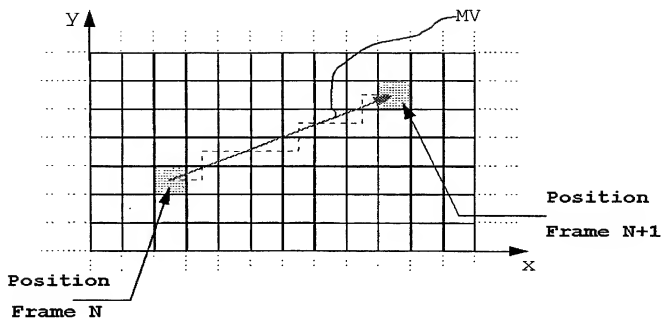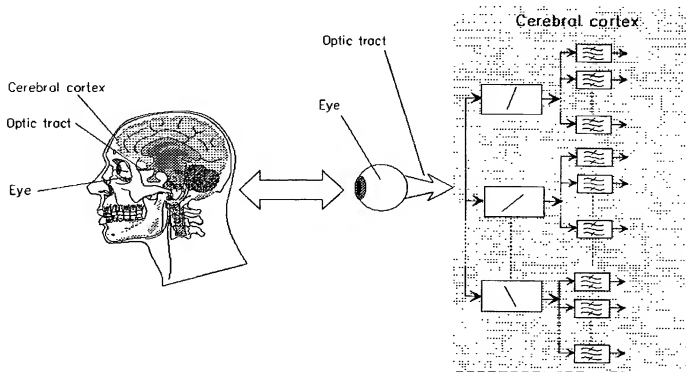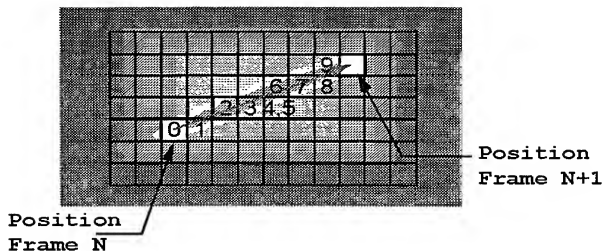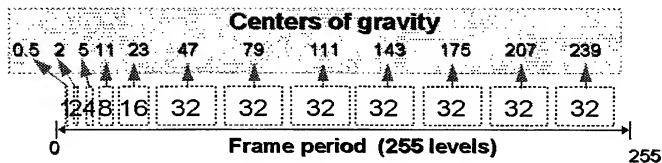
Fig. 1

Fig. 2

Fig. 10

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Position
Frame N+1

Position
Frame N

Fig. 8

Position
Frame N+1

Position
Frame N

Fig. 9

Centers of gravity

0.5 2 5 11 23 47 79 111 143 175 207 239

1 2 4 8 16 32 32 32 32 32 32 32

0 ————————— **Frame period (255 levels)** ————————— 255

Fig. 11

Position
Frame N+1

Position
Frame N

Fig. 12

Position
Frame N+1

Position
Frame N

Fig. 13

0%   50%   100%

1%   S%

Round down to
$\triangle_N$

Round up to
$\triangle_N + 1$

Use two positions

$\triangle_N$ and $\triangle_N + 1$

Fig. 14

Position Frame N+1

Position Frame N

Fig. 15

Position Frame N+1

Position Frame N

Fig. 16

EXPRESS EV025962...
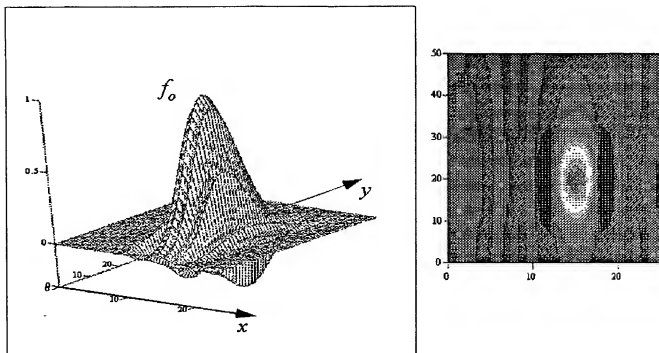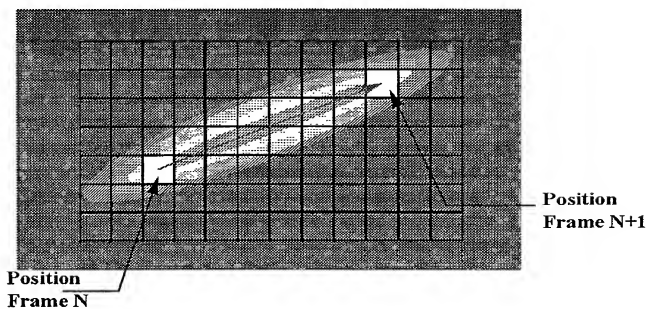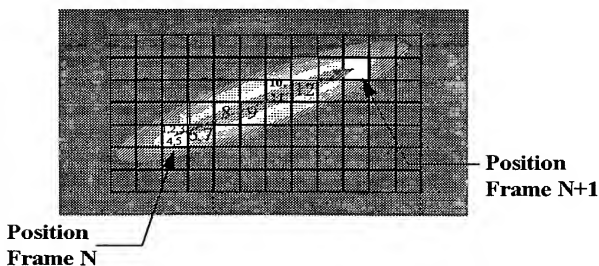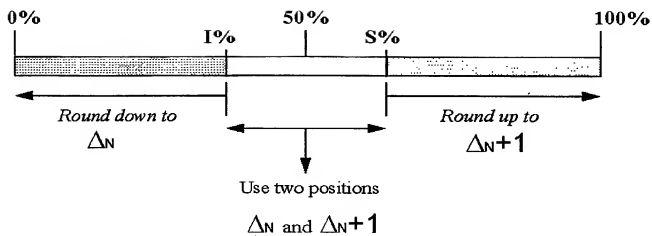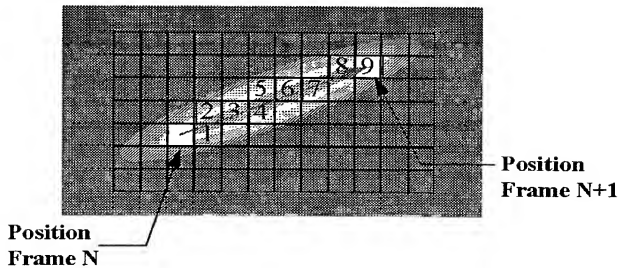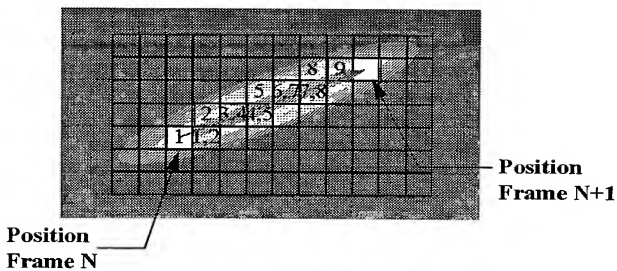
DECLARATION FOR UNITED STATES PATENT APPLICATION,
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

METHOD FOR PROCESSING VIDEO PICTURES FOR DISPLAY ON A DISPLAY DEVICE

the specification of which
(CHECK ONE)   ( )   is attached hereto.
                (xx)   was filed on September 23, 2000, Application Serial. No. PCT/EP00/09311
                        and was amended on .
        I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.
        I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 CFR 1.56(a).
        I hereby claim foreign priority benefits under 35 USC 119 of any foreign application(s) for patent, utility model, design or inventor's certificate having a filing date before that of the application(s) on which priority is claimed:

	Prior Foreign Application(s)		Priority Claimed	
Number	Country	Date Filed	Yes	No
99118990.3	EP	September 27, 1999	xx	

        I hereby claim the benefit under 35 USC 120 of any US Application(s) listed below, and, insofar as the subject matter of each of the claims of this Application is not disclosed in the prior US application in the manner provided by the first paragraph of 35 USC 112, I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 CFR 1.56(a).

Serial No.:   Filed:

        I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that wilful false statements and the like so made are punishable by fine or imprisonment, or both, under of 18 USC 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.
        I hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: Joseph S. Tripoli (Reg. No. 26,040) Telephone: (609) 734-9443.
        Address all correspondence to Joseph S. Tripoli, Patent Operations - Thomson multimedia Licensing, Inc. - CN 5312 - Princeton, New Jersey 08543-0028.

Signature: _____   Date: 2 2 day of ___January___ ,2002.
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Residence and Post Office Address: Chabeuilstr. 17
                                          D-78087 Mönchweiler
                                          Germany

Signature: _____   Date: 24 day of ___January___ ,2002.
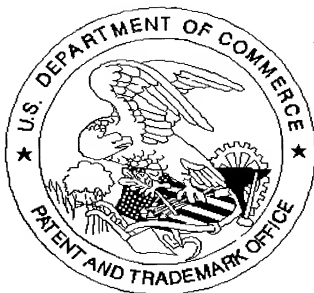Second Joint Inventor: Rainer Zwing
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